



ILRS Governing Board Meeting

23 Oct 2019
Stuttgart, Germany

Toshimichi Otsubo
Hitotsubashi University
Chair of ILRS Governing Board

Welcome

ILRS GB Members 2019-2020

Ex-Officio Members:

Michael Pearlman (Director, Central Bureau)
Carey Noll (Secretary, Central Bureau)
Urs Hugentobler (Representative of IAG Comm 1)

Appointed Members:

Daniela Thaller (IERS representative to ILRS)
Giuseppe Bianco (Eurolas Network Rep.)
Georg Kirchner (Eurolas Network Rep.)
James Bennett (WPLTN Network Rep.)
Zhang Zhongping (WPLTN Network Rep.)
Jan McGarry (NASA Network Rep.)
Stephen Merkowitz (NASA Network Rep.)

Elected Members:

Vincenza Luceri (Analysis Center Rep.)
Erricos C. Pavlis (Analysis Center Rep.)
Christian Schwatke (Data Center Rep.)
Jean-Marie Torre (LLR Rep.)
Toshi Otsubo (At Large Rep., Chair)
Matt Wilkinson (At Large Rep.)

Appointed Members by the GB:

Ulrich Schreiber
Krzysztof Sońnica

Short Report from IAG EC

Palais des congrès de **Montréal**



New IAG Executive Committee (2019-2023)

President

Zuheir Altamimi (France)

Vice-President

Richard Gross (USA)

Secretary General

Markku Poutanen (Finland)

President of the Communication and Outreach Branch

Szabolcs Rozsa (Hungary)

President of Commission 1: Reference Frames

Christopher Kotsakis (Greece)

President of Commission 2: Gravity Field

Adrian Jäggi (Switzerland)

President of Commission 3: Earth Rotation and Geodynamics

Janusz Bogusz (Poland)

President of Commission 4: Positioning and Applications

Allison Kealy (Australia)

New IAG Executive Committee (2019-2023) (cont.)

Service Representatives

Johannes Böhm (Austria)

Tom Herring (USA)

Toshimichi Otsubo (Japan)

Inter-Commission Committee on Theory

Pavel Novak (Czech Rep.)

Members-at-large

Sonia Costa (Brazil)

Yamin Dang (China)

GGOS Chair

TBD (as of July 2019)

IAG Fellows 2019

Among 44 people newly named, ILRS people are:

G Bianco (ILRS Chair of GB)

L Combrinck (EC member-at-large)

U Hugentobler (WG 4.2.4 Chair)

J Müller (GGOS BNO C3 Chair)

E Pavlis (ILRS Analysis Coordinator)

U Schreiber (WG 1.1.1 Chair)

D Thaller (IERS CB Director et al.)

New IAG Fellows 2019

Name	First Name	Position	Name	First Name	Position
Agren	Jonas	SC 2.2 Chair	Kuglitsch	Franz	Assistant Secretary Gen.
Alizadeh	Mahdi M.	WG 4.3.3 Chair	Labrecque	John	GGOS Focus Area 2 Chair
Bergstrand	Sten	JWG 1.1 Chair	Luzum	Brian	IERS Chair of the DB
Bianco	Guiseppe	ILRS Chair of the GB	MacMillan	Dan	WG 1.4.2 Chair
Collilieux	Xavier	SC 1.2 Chair	Martinez	William	SC 1.3b Chair
Combrinck	Ludwig	EC Member-at-Large	Muller	Jurgen	GGOS BNO C3 Chair
Crespi	Mattia	ICCT Vice-President	Nievinski	Felipe	WG 4.3.9 Chair
Douša	Jan	WG 4.3.7 Chair	Nothnagel	Axel	IAG EC Services Repr.
El-Mowafy	Ahmed	SG 4.4.1 Chair	Pacione	Rosa	JWG 4.3.8 Chair
Eschmann	Christian	WG 4.2.3 Chair	Paffenholz	Jens-Andre	WG 4.1.3 Chair
Flechtner	Frank	SC 2.3 Vice-chair	Pavlis	Erricos	ILRS Analysis Coordinator
Flury	Jacob	JWG 2.1 Chair	Schreiber	Ulrich	WG 1.1.1 Chair
Geng	Jianghui	SG 4.4.2 Chair	Seitz	Isabela	WG 1.4.1 Chair
Gikas	Vassilis	SC 4.1 Chair	Skaloud	John	WG 4.2.1 Chair
Heinkelmann	Robert	JWG 1.3 Chair	Stanaway	Richard	WG 1.3.1 Chair
Hirt	Christian	IDEMS Advisory Board	Thaller	Daniela	IERS CB Director et al.
Hoque	Mainul	WG 4.3.2 Chair	Tsai	Lung-Chih	WG 4.3.5 Chair
Horwath	Martin	SC 1.3f Chair	Vergos	Georgios	IGFS Director of CB
Huang	Chengli	Commission 3 Vice-Pres.	Wielgosz	Pawel	SC 4.4 Chair
Hugentobler	Urs	SC 1.1 Chair	Wzientek	Hartmut	IGETS & JWG 2.1.1 Chair
Kalantari	Mohsen	WG 4.2.4 Chair	Zhang	Xiaohong	WG 4.4.2 Chair
Kenyeres	Ambrus	SC 1.3a EUREF TGW			

First IAG Executive Committee Meeting (18 July 2019, Montreal)

Self-introduction

Structure of Commissions and ICCT

Status of GGOS

Status of outreach branch

Representation of services

Others



T Otsubo
to cover ILRS and IGFS.
Twice/year reports!

Next meeting: 7 Dec 2019, San Francisco

GGOS President

In Montreal, July 2019

Renamed from “GGOS Chair”

Vacant because of R Gross elected as IAG Vice President

No conclusion was made in Montreal.

E-mail voting among IAG EC
in September 2019

→ Elected **Basara Miyahara** (GSI, Japan)
taking this position & IAG EC on 1 Nov.



IAG Newsletter?

Email from Szabolcs Rózsa

Contribution to the IAG Newsletter - October, 2019

Dear IAG EC-Members and IAG Service Directors, Chairs:

Since the IAG Newsletter October 2019 issue is currently under preparation, we kindly ask you to send us your inputs (announcements, commemoration for important geodesists passed away, highlights of scientific achievements, news, reports, reviews, etc) which you think are worthwhile for publication in the IAG Newsletter. Please send me (szrozsza@iag-aig.org) your input and one copy to the following address: newsletter@iag-aig.org. The deadline for the submission is **October 29**.

I would like to remind you that all of your inputs are welcome to the IAG Homepage (<http://www.iag-aig.org>), too! Please send us short reports, articles with photos/figures of important geodetic achievements or any important activities related to geodesy, that could be interesting for both the geodetic and the general public!

I'm looking forward to receiving your answer by the given deadline!

Thank you! Sincerely yours, Szabolcs Rózsa President, IAG COB

Collaboration with other
services etc

[1] Kunming workshop?

GGOS or Inter-service session?

Invite someone from other services?

Laser Ranging School

- One day school on October 20
- 40+ participants from 15 countries (incl. China, Australia, Japan, US)
- Lots of discussion
- Survey input from participants yet to be reduced
- Comments
 - Response so far very positive
 - Schedule tight; suggest at least 2 days in the future
 - More interactive exercises

SLR School | Agenda

- **Session 1: Introduction to the Satellite Laser Ranging Technique**
 - Introduction: Mike Pearlman
 - Satellite laser ranging (John Degnan/60 min)
 - Lunar laser ranging (Jean-Marie Torre and Doug Currie/20 min)
- **Session 2: Data Analysis**
 - Role and function of the Data Centers (Carey Noll/20 min)
 - Analyzing of SLR observations - what do we do with the data? (Mathis Blossfeld/25 min)
 - Data analysis demonstration - data download and normal point computation (Alex Kehn/ 25 min)
 - Reference frames and geodetic products (Daniela Thaller/20 min))
- **Session 3: Corrections and Error Sources**
 - What corrections do we add to our basic range data? (Jose Rodriguez/15 min)
 - How do we calibrate? (Ivan Procházka/15 min)
 - What are the error sources to our ranging data? (Ivan Procházka/15 min)
 - Accurate timing; (Ivan Procházka/15 min)
 - The importance of ground surveys and how do we do them (Johann Eckl/15 min)
 - Spacecraft center of mass modeling; (Jose Rodriguez/15 min)
- **Session 4: Station Operations and Other Applications of Satellite Laser Ranging**
 - Space debris, technique and applications (Michael Steindorfer/20 min)
 - SLR Operations
 - SLR Tracking: (Rob Sherwood/20 min)
 - In-sky Safety: (Matt Wilkinson/20 min)
 - Building a SLR Station in 2019: (André Kloth and Sven Bauer/20 min).
- **Wrap up**



ILRS

Central Bureau Report

Carey Noll
Michael Pearlman
ILRS Central Bureau

2019 ILRS Technical Workshop
October 21, 2019
Stuttgart, Germany

Outline

- GB overview
- Recent developments
 - ◆ Network
 - ◆ Missions
 - ◆ Infrastructure
 - ◆ Operations
- ◆ ILRS 2016-2019 Report

ILRS Governing Board: 2019-2020



- Elected positions:
 - ◆ EUROLAS Network Representatives: **Pippo Bianco, Georg Kirchner***
 - ◆ NASA Network Representatives: **Jan McGarry, Stephen Merkowitz***
 - ◆ WPLTN Representatives: **James Bennett, Zhang Zhongping**
 - ◆ Data Center Representative: **Christian Schwatke***
 - ◆ LLR Representative: **Jean-Marie Torre***
 - ◆ Analysis Representatives: **Cinzia Luceri*, Erricos Pavlis***
 - ◆ At-Large Representatives: **Toshi Otsubo* (Chair), Matt Wilkinson***

- Ex-officio/appointed positions:
 - ◆ Director of the Central Bureau: **Mike Pearlman**
 - ◆ Secretary of the Central Bureau: **Carey Noll**
 - ◆ Representative of IAG Commission 1: **Urs Hugentobler**
 - ◆ IERS Representative: **Daniela Thaller**
- Appointed by the Governing Board:
 - ◆ **Ulli Schreiber***
 - ◆ **Krzysztof Sośnica**

Note: * SC/SG chair/co-chair



Standing committees/study groups



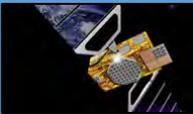
- Analysis SC
 - ◆ Erricos Pavlis
 - ◆ Cinzia Luceri
- Data Formats and Procedures SC
 - ◆ Christian Schwatke
 - ◆ Randy Ricklefs
- Missions SC
 - ◆ Stephen Merkowitz
 - ◆ Toshi Otsubo
- Networks and Engineering SC
 - ◆ Matt Wilkinson
 - ◆ Georg Kirchner
- Transponder SC
 - ◆ Ulli Schreiber
 - ◆ Jean-Marie Torre
- Space Debris SG
 - ◆ Georg Kirchner
 - ◆ Daniel Kucharski



Recent developments: general



- Posted all material (presentations, posters, some papers, summary information) from Canberra workshop
- Held first “SLR School” before this workshop
- Established ILRS tracking strategy for GNSS
- Published new mission support request guidelines
- Developed draft Memorandum of Understanding between ILRS/GGOS and ROSCOSMOS
- Installed new SLR QC process at ILRS OCs
- Published ILRS workshop planning guidelines
- Finalizing Journal of Geodesy Special Issue on Laser Ranging
- Compiling 2016-2018 ILRS report



Recent developments: network

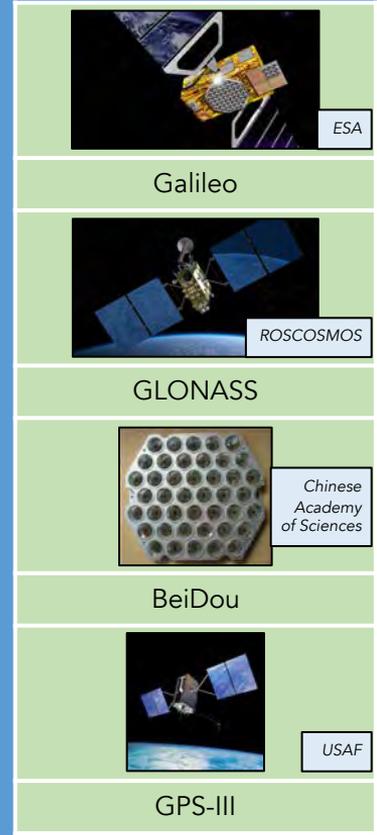


- Station closings:
 - ◆ MLRS, McDonald, TX: lightning strike; to be replaced by SGSLR
- Upgraded stations:
 - ◆ Simosato (Japan): kHz operations late 2018
 - ◆ Wuhan (China): submitting data (in quarantine)
 - ◆ BKG AGGO (Argentina): continuing setup La Plata Observatory; TIGO relocation
 - ◆ San Juan (Argentina): kHz, operations planned for 2020
- Quarantined stations:
 - ◆ Wuhan, China (new station; under evaluation)
 - ◆ San Fernando, Spain (irregular data submission)
 - ◆ Tanegashima, Japan (irregular data submission)
 - ◆ Geochang, Korea (new station; no data)
- New station installations underway/planned

GNSS tracking strategy



- Large number of GNSS satellites
 - ◆ GNSS agencies have different requirements for ILRS tracking support
 - ◆ More satellites coming with GPS-III
 - ◆ GNSS tracking strategy put in place after consultation with missions, IGS, and the ICG
- Strategy:
 - ◆ Each constellation selects 4 satellites for higher priority tracking (3 segments of tracking requested per pass)
 - ◆ All of the remaining GNSS satellites are tracked at lower priority on a non-interference basis with all of the other ILRS requirements (sampling approach)
- Concentrated tracking in special campaigns (e.g., eclipsing)



New mission support guidelines



- ILRS carefully reviews new mission support requests based on need and likelihood of success in meeting their tracking requirements
- Recent MSR's showed need for more information earlier in request process
- New guidelines for missions to address prior to submitting MSR:
 1. Does SLR provide a unique capability that other tracking systems cannot? Is SLR the primary or secondary tracking technique? Can the tracking requirement be met by another technique?
 2. What added value will SLR data provide to the data products?
 3. Has the mission sufficiently quantified its tracking requirement (accuracy, data volume, coverage, etc.)? Does the mission have a vulnerable payload aboard that will require special tracking procedures?
 4. What is the procurement source of the retroreflector array(s)? Does the design include accommodation for the velocity aberration?
 5. Has the signal link budget been estimated either through comparison with spacecraft already tracked by SLR or through the link equation?
 6. Have provisions been made to provide reliable predictions in CPF format? Has this source tested their CPF files or are there plans to do such testing?
- Distributed and posted on ILRS website Feb-2019

OC data screening: updates



- ILRS OCs (NASA and EDC) updated incoming data screening process and criteria
 - ◆ Implemented more thorough QC procedures to improve ILRS data product for the user community
 - ◆ Harmonized process between EDC and NASA Ocs
 - ◆ Data screened and characterized as:
 - Valid: passed screening; data released
 - Errors: adversely impact quality of data and products (e.g., invalid date, invalid satellite, erroneous calibration, etc.); data not released
 - Warnings: minor impact on data quality; data released
- Process operational 15-Aug-2019
- Criteria posted on ILRS website:
https://ilrs.gsfc.nasa.gov/network/site_procedures/data_screening_procedure.html

New formats: data and site logs



- CRD and CPF formats
 - ◆ Issued version 2 of both formats; final input on any modifications due
 - ◆ Facilitate support of future missions and applications (e.g., ELT, space debris)
 - ◆ Transmitting test data and predictions
 - ◆ Implementation date goal: end of 2020
- Site logs
 - ◆ Updated format to add more information about station configuration and operations
 - ◆ Implemented improved web-based procedures at EDC for submitting/updating station site logs
 - ◆ Tool supports station personnel in keeping site logs current
 - ◆ ILRS CB reviewed many logs to push new version to operational status
 - ◆ New procedure operational: 15-Sep-2019

Station/data evaluation/reporting



- Station assessment tool
 - ◆ Allows station personnel, analysts, CB to view network capabilities (e.g., #passes, #normal points, adherence to ILRS guidelines, etc.)
 - ◆ Emphasizes value of station performance to the user community and to the creation of science products
 - ◆ Shows areas of improvement to support ILRS goals
 - ◆ Generated monthly, reflects data assessed over the previous 12 months
- ILRS report cards
 - ◆ Generated since 2012
 - ◆ Required update of legacy software
 - ◆ Developed new software; under evaluation to compare results to legacy reports
 - ◆ Affects station and satellite-specific plots

Workshop planning guidelines



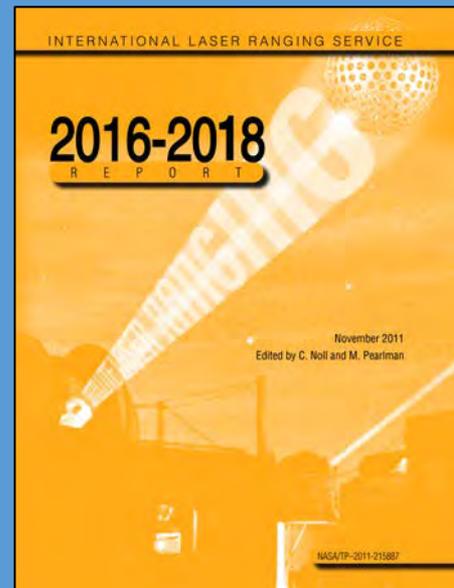
- International Workshops on Laser Ranging (IWLR)
 - ◆ Held every 2 years
 - ◆ ILRS CB requests proposals 3 months before next workshop
 - ◆ Host for next workshop selected at current workshop
 - ◆ Request proceeding papers
- Technical/Specialized ILRS Workshop
 - ◆ Held every 2 years between IWLR
 - ◆ Focus on topic of current importance
 - ◆ ILRS CB requests proposals 1.5-2 years prior; reviewed by GB
- All material made available to CB for posting on workshop websites
- Schedule for upcoming workshops:
 - ◆ 2020: 22nd IWLR in Kunming, China
 - October 2019: LOC presentation
 - ◆ 2021: Technical/Specialized Workshop
 - October 2019: begin search
 - January 2020: close search, GB review
 - March 2020: Notify host, community
 - October 2020: LOC presentation
 - ◆ 2022: 23rd IWLR
 - July 2020: begin search
 - October 2020: LOC presentations at 22nd IWLR and vote from attendees



ILRS 2016-2018 Report: Status

Carey Noll
Michael Pearlman
ILRS Central Bureau

2019 ILRS Technical Workshop
October 21, 2019
Stuttgart, Germany



General information



- Began effort in early 2019 by identifying, then contacting, authors, contributors, etc.
- Include individual reports from stations, ACs/AACs/LAACs/CCs, SCs/SG
- Contributions have been slow to arrive
- Editing within ILRS CB
- Final publishing to be determined (NASA?)
- Limited number of printed copies (per request only)



Report outline and status



- Sections

- ◆ Preface, etc. (50% complete)
 - Dedications?
 - Chairpersons remarks (COMPLETE)
- ◆ Introduction (R. Gross/COMPLETE)
- ◆ SLR Contributions to Science
- ◆ About the ILRS (COMPLETE)
- ◆ ILRS Operations (90% complete)
- ◆ Emerging Technology (COMPLETE)
- ◆ Mission Reports (90% complete)

- Sections (continued)

- ◆ AC/AAC/LAAC/CC Reports
 - 2 of 7 AC reports received
 - 5 of 20 AAC reports received
 - 2 of 6 LAAC reports receive
- ◆ Station Reports (25 of 43 reports received)
- ◆ SC/SG/Board Reports (5 of 7 reports received)
- ◆ ILRS Meetings (COMPLETE)
- ◆ Appendices

ESA/ESA DC application



- GNSS Science Support Centre (GSSC)
- Application for ILRS data center
- Currently serves as an IGS Global Data Center (1 of 6)

From the ILRS ToR:



- The Global Data Centers are the primary interfaces to the Analysis Centers and the outside user community. Their primary tasks include the following:
 - ◆ Receive/retrieve, archive and provide online access to tracking data received from the Operations Centers/Regional Data Centers (this includes data from ALL satellites and ALL stations)
 - ◆ Provide online access to ancillary information, such as site information, occupation histories, meteorological data, site specific engineering data, satellite orbit information, satellite predictions, center of mass values, and other related information
 - ◆ Receive/retrieve, archive and provide online access to ILRS scientific data products received from the Analysis Centers
 - ◆ Backup and ensure the integrity of ILRS data and products
- Other items:
 - ◆ CDDIS/EDC developed and maintains the software.
 - ◆ We have evolved to the point where the boundary between the DC's and the OC's is not firmly defined; lots of interact

- How do you intend to populate your archive of ILRS data, products, and information? Do you plan to mirror the contents of CDDIS and EDC?
 - ◆ *“Yes, unless you provide us with specific interface requirements we will pull the data from your site on a TBD basis (daily?)”*
- It should be noted that these two data centers archive SLR data in different ways, which can be explained in more detail later.
 - ◆ *“We are aware of that and this is a point that should be discussed in order to avoid duplicates.”*
 - ◆ *“Your preferences for data organisation on the GSSC side should be discussed.”*
- Other comments:
 - ◆ *“ESAC will soon release GSSC exploitation platform.”*
 - ◆ *“While right now GSSC is an archive accessible via FTP only, new discovery, access and analysis services are to be provided along with new collections (hopefully ILRS data).”*

- What is the benefit to the ILRS of a third data center?
- Increased workload, complications to ILRS data flow?
- Does the ILRS infrastructure NEED another data center?
- But how does the ILRS “say no” to the application?
- Political concerns at existing data center(s)
- Possible solution: Associate Data Center
 - ◆ Never existed before
 - ◆ Not recognized in ToR



ILRS ASC & QCB Activities

Cinzia Luceri and Erricos C. Pavlis

ILRS Analysis Coordinators

ILRS Governing Board Meeting

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October 23 2019

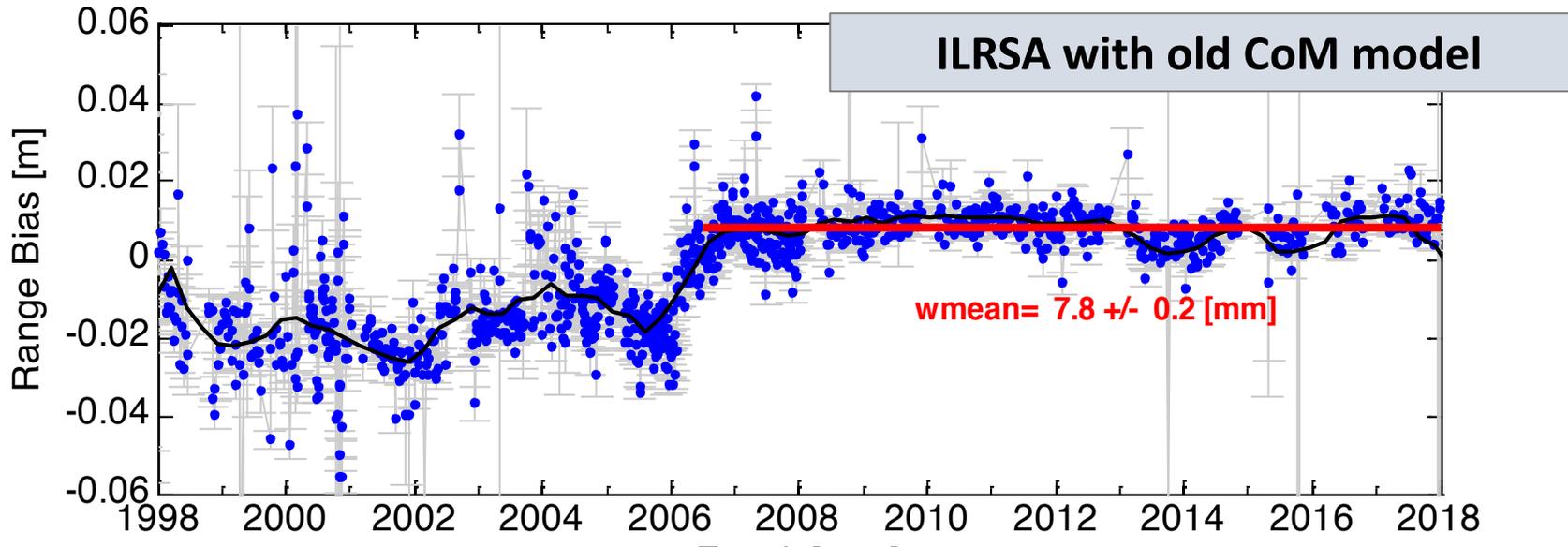
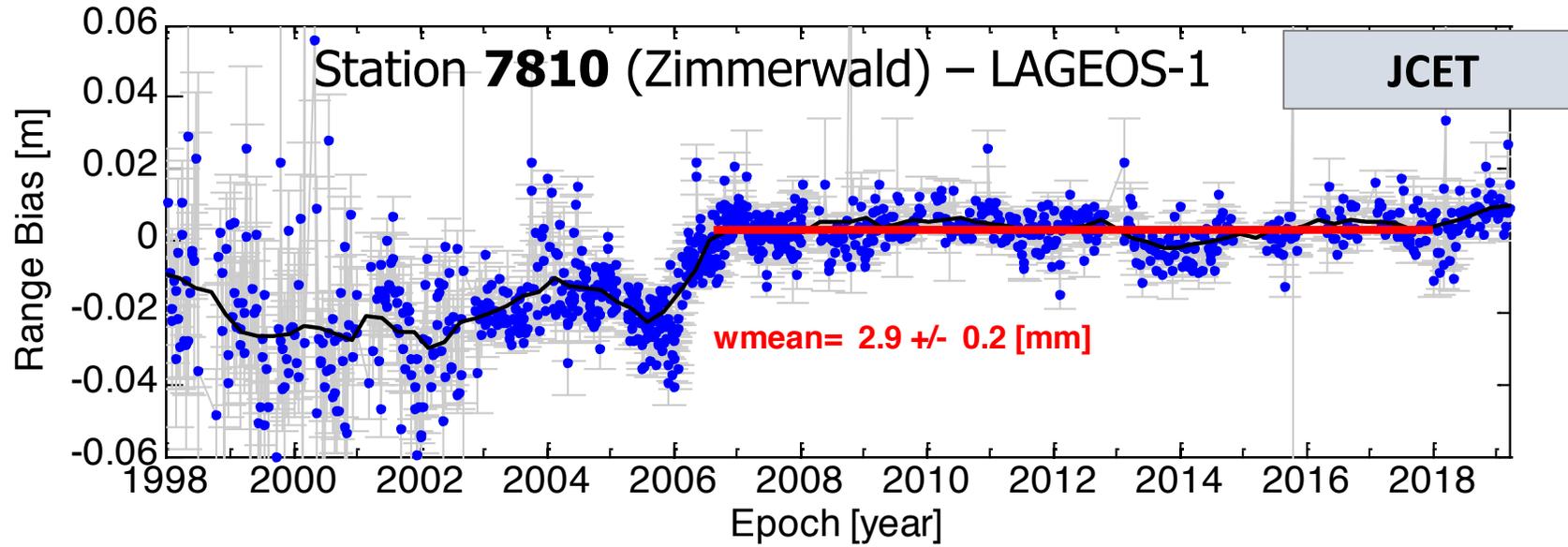
- Preparations for contributing to the development of ITRF2020 are on schedule
- New operational approach in handling error sources:
 - Allowance for estimation of systematic errors simultaneously with all other parameters to eliminate biases in station positions/velocities (SSEM PP in progress);
 - A new model for the target signature (also known as “CoM correction”) for all types of ground systems delivered by NSGF and already adopted by the AC for the SSEM PP;
 - Time Biases added in the adopted data handling file:
 - Time biases are now modeled based on T2L2 results
 - Additional time biases from T2L2 until the end of 2017 added

- SSEM Pilot Project on station systematics
 - Reanalyzing of the data since 1993
 - awaiting the final submission from ALL ACs to complete the combination product and the tabular form of the new model;
- The result will be used as the basis for the development of the ILRS product that will be contributed to ITRF2020;
- We will include applied RB & TB in SINEX file for next contribution to ITRF with their constraint information in each SINEX combined product and the applied CoM offsets for that weekly product. Three separate sections in the SINEX COMMENT block

ILRS ASC – New CoM model



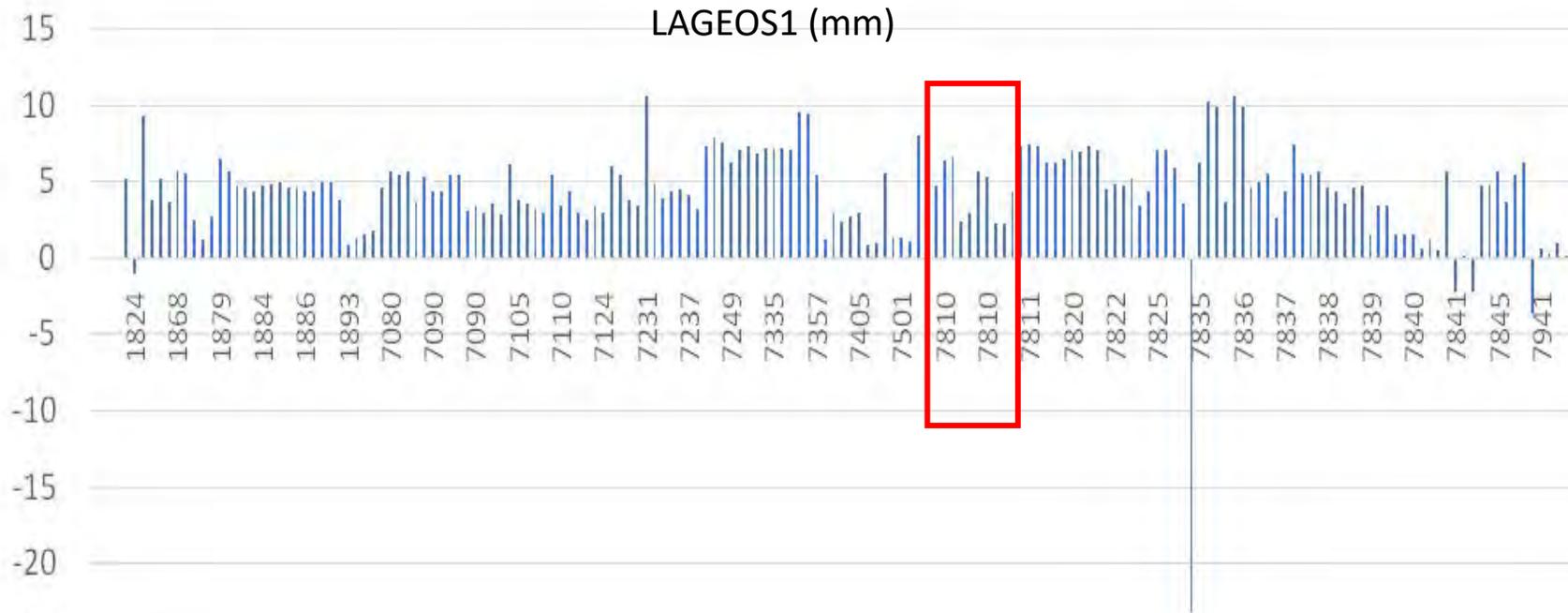
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ILRS ASC – New CoM model



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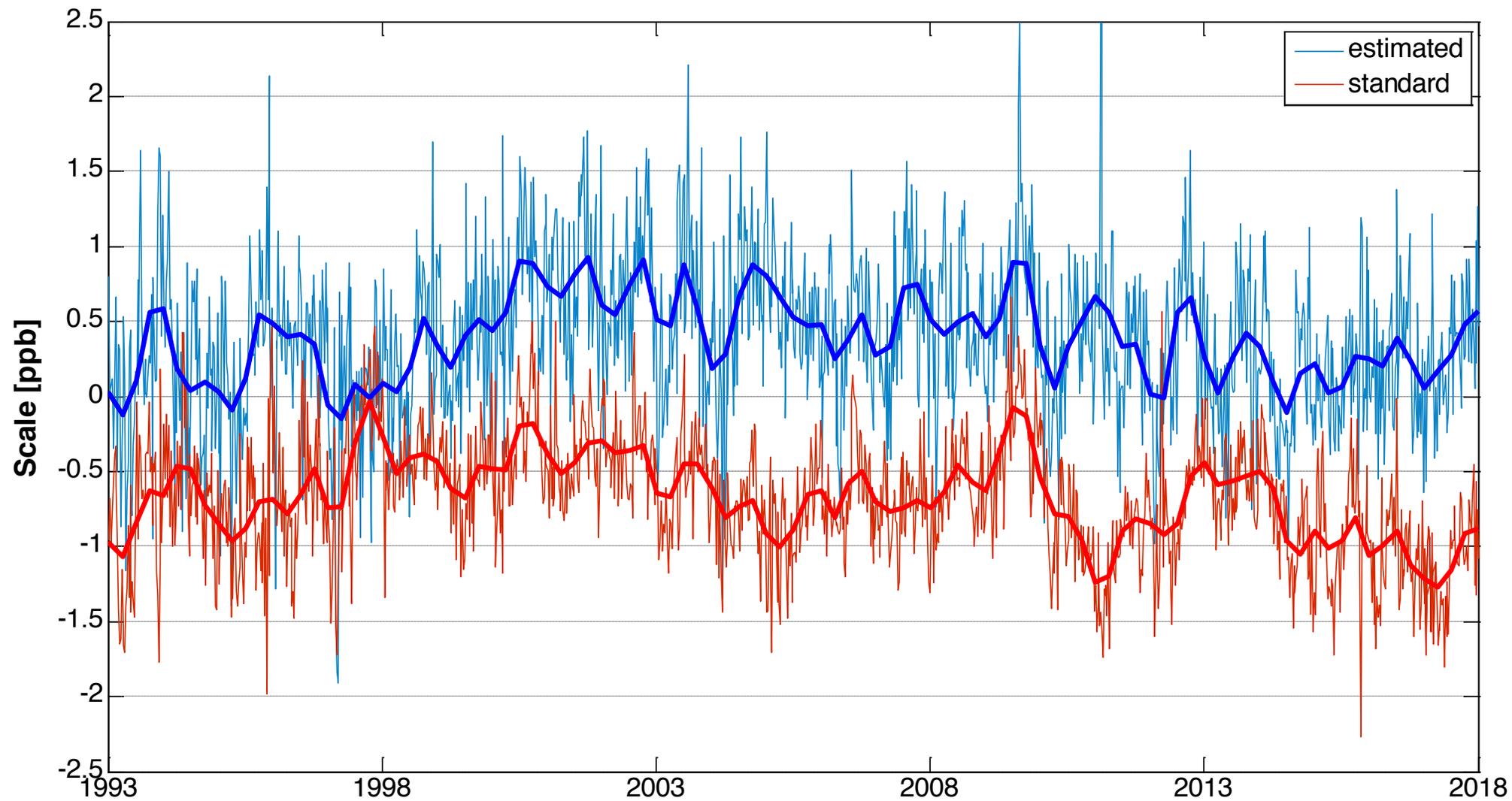


Old CoM model

New CoM model

7810	1/1/1980	30/4/1995	251	01/01/1983	01/06/1995	244,6
				01/01/1986	01/06/1995	244,4
7810	2/1/1996	9/3/2001	245	01/01/1997	09/03/2001	242,6
7810	9/3/2001	18/2/2008	248	09/03/2001	11/03/2003	245,0
7810	4/3/2008	31/12/2050	249	11/03/2003	03/02/2006	243,4
				03/02/2006	18/02/2008	243,7
				01/01/2002	18/02/2006	246,8
				18/06/2006	18/02/2008	246,7
				18/02/2008	01/01/2050	244,7

ILRS ASC – ILRSA Scale

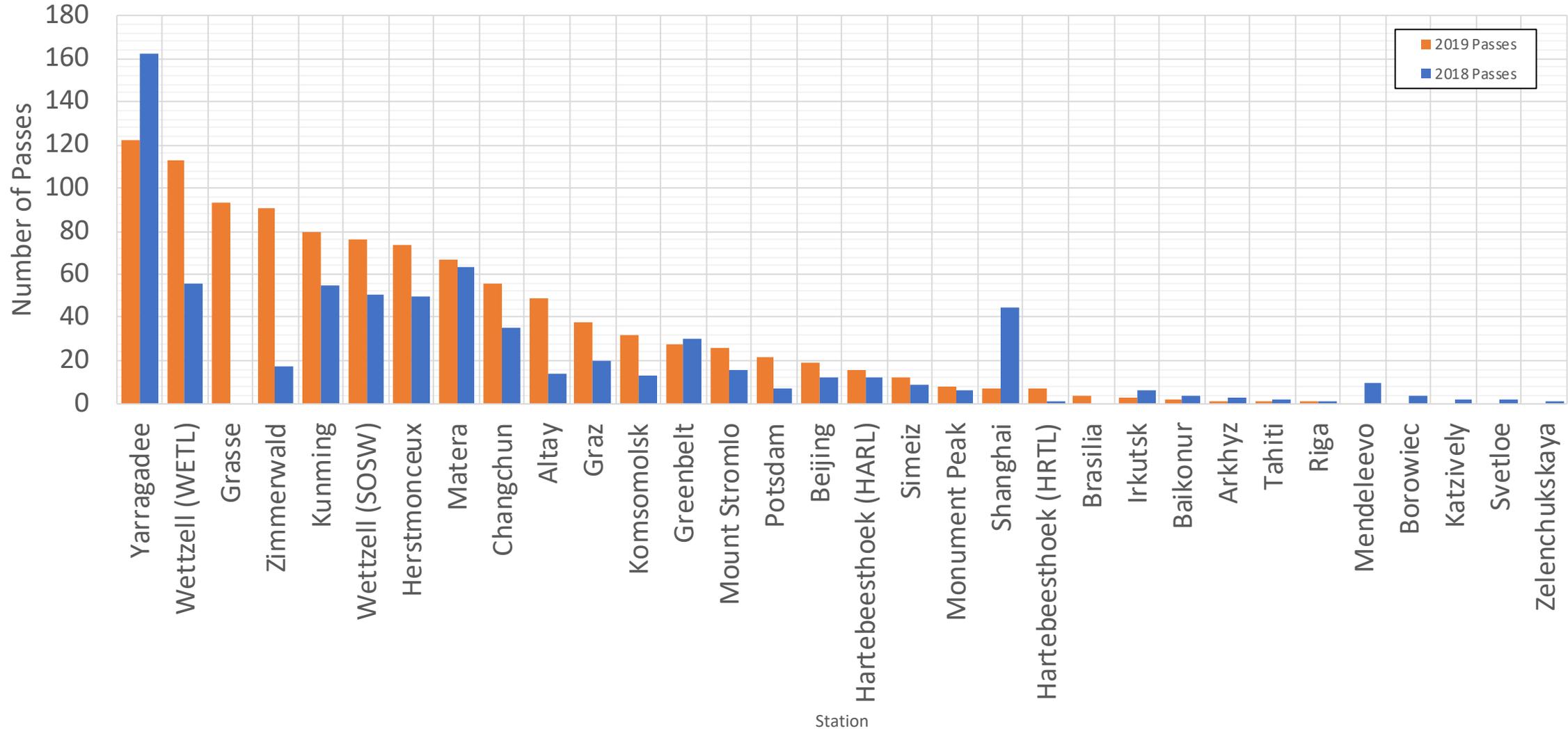


Etalon 1 & 2 Campaign Project



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Etalon Pass Totals (Feb. 15-May 15, 2018 and 2019)



Repeatability Improvement in EOP Estimates vs IERS C 04

- 2018 Non-Campaign Period

CASE	MEAN	STD	RMS
X (ILRS-IERS) [μ as]	237.106	213.361	318.177
Y (ILRS-IERS) [μ as]	-14.677	211.007	210.230
LOD (ILRS-IERS) [μ s]	-3.409	43.595	43.521

- 2019 Campaign Period

CASE	MEAN	STD	RMS
X (ILRS-IERS) [μ as]	246.291	134.835	280.453
Y (ILRS-IERS) [μ as]	19.722	172.845	173.088
LOD (ILRS-IERS) [μ s]	6.590	36.875	37.274

-37%

-18%

-15%

Etalon 1 & 2 Campaign Project



- We collected more data overall
- The network can be split in two tiers of stations based on NP data collected:
 - The top 12 and
 - The rest
- Of the top producers, Yarragadee, WLRS, MLRO, ZimLAS and MeO showed a consistent increased yield every week, although the weather did play a role in the observed variations.
- For the bottom tier sites with the single-digit weekly yield we will have to wait for the in-depth analysis to see if these few points make any contribution to the products (e.g. due to the geographical location of these sites). Otherwise it will probably be better for these sites to focus on other targets.
- Based on the 3-month tracking in 2018 and 2019, we deduced the equivalent annual yield for the network for these two years. It is clear that the 2019 results could be double (or more) the amount of the 2018 data set. From this point of view the campaign is clearly a success.

- PP for systematic error estimation will move to the next phase to produce the new model
- The operational phase of the SSEM PP will start after a dry run, probably around March 2020 in order to have the first results for the EGU. The weekly solution, v230 style, will have a latency to be decided
- Preparations for the development of ITRF2020 are ongoing
- Next PP will deliver low-degree gravity coefficients as a weekly product and introduce LARES as a 5th target for ITRF product support (by end of 2019)
- Finally, PP for observational-level modeling of loading corrections for stations and corresponding gravitational corrections in orbit (operational product) [summer 2020 ???]

- The Quality Control Board (QCB) addresses laser ranging data quality issues via bi-monthly telecons:
 - Data QC website with the results of current provider ACs in SLRF2014 ;
 - Web-based performance tools based on the inputs from the Station Report Card (Quarterly & Monthly) online
 - Online Engineering Forum Tool
 - Examining NP consistency vs FR data, methods employed by stations to form their NPs, etc.
- Updates to site log format completed, added information about station configuration and operation, site surveys, etc.
- New online tool to examine and to “rate” station performance underscoring value to the users and science products:
 - [Monthly Station Performance Assessment](#)

JOGSILR Articles Lineup



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- *Preface to the second Special Issue on Laser Ranging*
- The ILRS: Approaching twenty years and planning for the future
- Geodetic Satellites: A High Accuracy Positioning Tool
- Lunar Laser Ranging - A Tool for General Relativity, Lunar Geophysics and Earth Science
- Information Resources Supporting Scientific Research for the International Laser Ranging Service
- The Next Generation of Satellite Laser Ranging Systems
- NASA's Satellite Laser Ranging Systems for the 21st Century
- Modernizing and Expanding the NASA Space Geodesy Network to Meet Future Geodetic Requirements
- Future SLR station networks in the framework of simulated multi-technique terrestrial reference frames
- Impact of network constraining on the terrestrial reference frame realization based on SLR observations to LAGEOS
- **Satellite Laser Ranging to Low Earth Orbiters - Orbit and Network Validation**
- **Rapid Response Quality Control Service for the Laser Ranging Tracking Network**
- Transitioning the NASA SLR network to Event Timing Mode for reduced systematics, improved stability and precision
- Systematic errors in SLR Data and their impact on the ILRS products
- Time Bias Service: Analysis and Monitoring of Satellite Orbit Prediction Quality
- Operating two SLR Systems at the Geodetic Observatory Wettzell - from local survey to space ties
- Time and laser ranging: A window of opportunity for geodesy, navigation and metrology
- Laser and Radio Tracking for Planetary Science Missions - A Comparison
- Assessment of the impact of one-way laser ranging on orbit determination of the Lunar Reconnaissance Orbiter
- Version of a glass retroreflector satellite with a sub-millimeter "target error"
- Studies on the materials of LARES 2 satellite



Data Formats and Procedures Standing Committee Status Report

Christian Schwatke¹, Randy Ricklefs²

¹ Deutsches Geodätisches Forschungsinstitut, Technische Universität München (DGFI-TUM)

² University of Texas / Center for Space Research (UT/CSR)

CRD and CPF (Version 2) - Implementation Schedule and Status

June 2018 • New “v2” directories set up on CDDIS and EDC

July 2018 • Released CPF v2 manual, sample code, and test data on CDDIS web site

September 2018 • Released CRD v2 manual, sample code, and test data on CDDIS web site
 • EDC-website provides an online tool for checking data with respect to the new CRD v2 and CPF v2 format

October 2018 • MLRS analysis code incorporates CRD v2 code.

December 2018 • One or two stations should be able to produce v2 CRD

- Graz (7839): since 2019-05-02
- Mt.Stromlo (7825): since 2019-07-15
- Herstmonceux (7840): since 2019-08-01

All stations are in “data quarantine“ until CRD v2 has been approved by the ASC

CRD and CPF (Version 2) - Implementation Schedule and Status

- January 2019**
- OCs, DCs should be able to handle v2 CPFs and CRDs
 - At least one prediction provider should be producing v2 CPFs
 - UTX: since 2018-12-05 (only LLR)
 - HTS: since 2019-03-06
 - OPA: since 2019-06-13

Used by Graz and Wetzell without problems

- Some analysts should be able to process v2 CRD files
 - JCET can already handle v2.00 CRD (and soon v2.01)

- October 2019**
- **Final update and release of CRD v2.01**
 - New records C7, 42 // 'na' instead of -1 for 'not applicable'

CRD and CPF (Version 2) - Implementation Schedule and Status

- ~~December 2019~~ • Almost all stations should be able to use v2 CPFs
- September 2020** (required for those tracking ELT)
- ~~January 2020~~ • All prediction providers should be producing v2 CPFs
- December 2020** • All analysts should be able to process v2 CRD files
- ~~June 2020~~ • Almost all stations should be producing v2 CRDs
- December 2021**

Task not completed!

Quality Control at the Operation Centers

- Until October 2018** • Thresholds for the CRD fields were defined
- Spring 2019** • Review by the NESC and other experts
- Summer 2019** • Final thresholds were implemented by both OCs.
 - Intensive tests were run by the NASA OC
- 15 August 2019** • New quality control standards have been applied for CRD (v1 and v2)

Task completed!

Updated Site Log Procedure (Format Version 2)

until August 2018 • Development of the new site log format (version 2)

September 2018 • New site log format has been released
 • 18 fields were updated // 100 fields were added
 • Latest site logs have been converted

October 2018 • “Site Log Manager” at the EDC-website has been released

January 2019 • Review and updated of site logs by the stations

February 2019 • Switch to the operational review process by the ILRS CB

August 2019 • Validation and correction of all site logs with errors by the “expert group”
 • 86 converted and validated site logs are available

September 2019 • Final transition to the new ILRS site log format!

Housson, Van Pavlis, Erricos Pearlman, Mike Ricklefs, Randy Schwatke, Christian

Task completed!



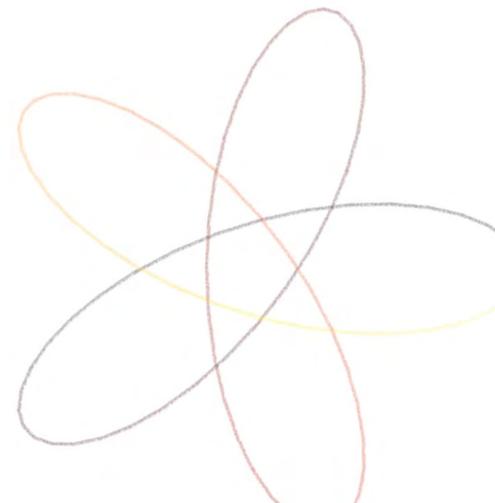
NETWORKS AND ENGINEERING STANDING COMMITTEE

ILRS TECHNICAL WORKSHOP 2019

STUTT GART, GERMANY

Chair: *Matthew Wilkinson*

Co-Chair: *Georg Kirchner*





AGENDA

- The new way in which the NESC will operate
 - Presentation (M. Wilkinson)
 - Discussion
- A discussion on what NESC priorities require a working panel
 - Who could lead these panels?
- Other suggestions for NESC focus



NESC WORKING

Presently, the NESC meets once a year at the ILRS workshops to discuss topical issues.

This is usually for an hour, at the end of a busy day. While these meetings are valuable, how much can be achieved and the level of detail that can be discussed is limited by the time available.

Also, if enough time was allowed to address a potentially high number of issues then this could lead to drawn-out and demanding meetings.

Earlier this year I sent out proposals on email to set out how I would like to change the operations of the NESC.



NESC AIMS

The NESC aims to identify technical challenges in SLR and approach them in a collaborative way. It can provide a network perspective and use the resource of knowledge and experience in the community.

The NESC doesn't have to control or direct all of the work in the community. But it should be aware of what is going on and try to facilitate work that could benefit SLR.

Where there are issues the NESC should bring together individuals that could work the problem through and find resolution.

I want to:

- Increase the activity in the NESC and open it up.
- Make the NESC a route through which to explore, to question and to change how we do things
- Enable the NESC to be able to take decisions.



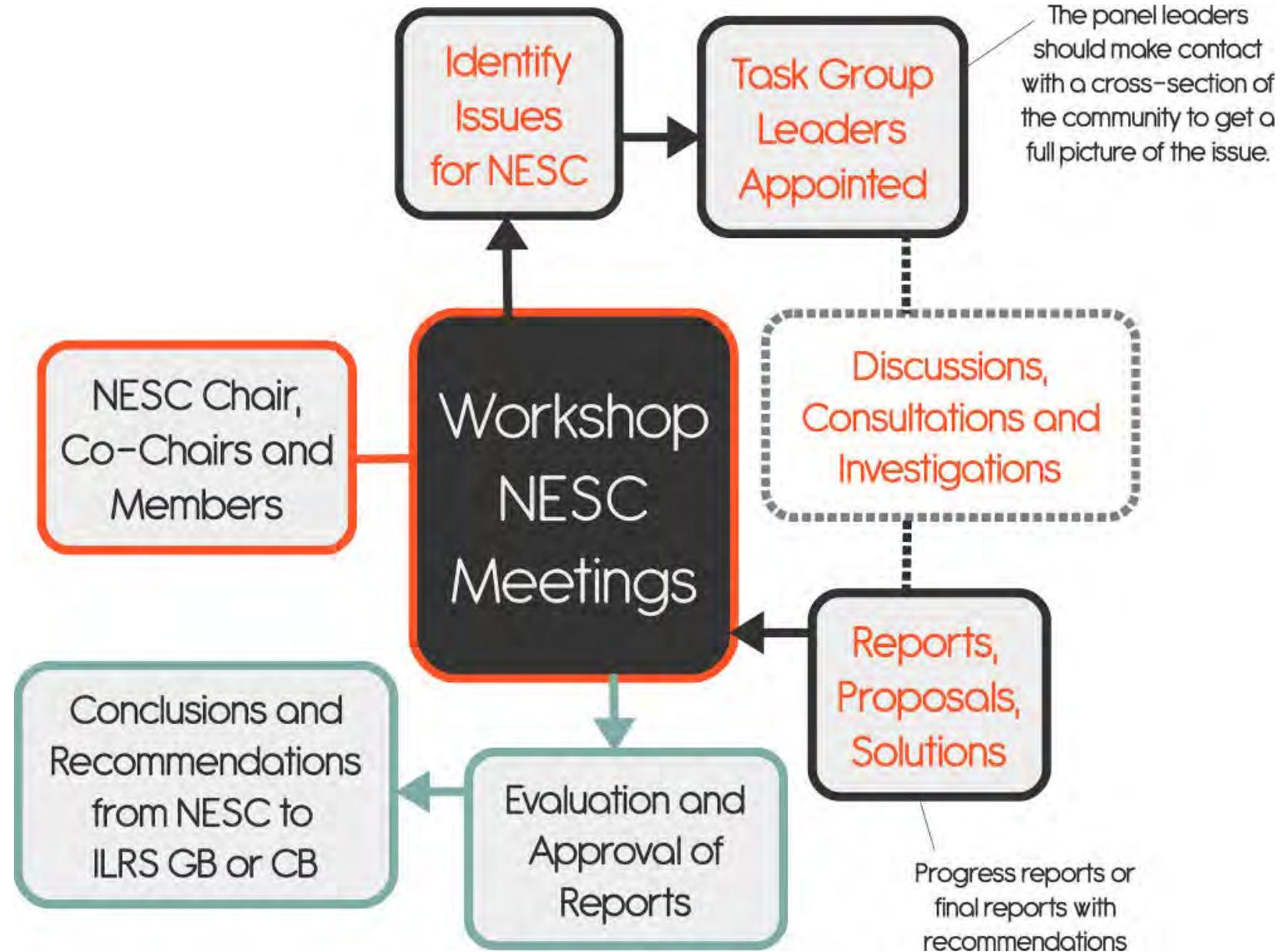
NESC MEMBERS

As a member of the NESC, you are needed to attend the meetings to discuss the progress of the NESC working panels.

You can bring ideas for the NESC to look in to and you are encouraged to contribute to the discussions in the panels.



NESC OPERATION





NESC OPERATION

- This will mean some work between meetings
- Panels should have a clear purpose:
 - To answer a question
 - Resolve an issue that has conflicting views
 - Pull together ideas
 - Perform a task
- Panels should be focussed with achievable tasks
- The time frame should not be open-ended
- Each panel would be required to report back to the NESC meetings. On the conclusion of the panel a short write up would be appropriate.
- NESC would consider and take forward any recommendations





NESC EXAMPLE

- **NESC review of the new CRD testing criteria.** The ILRS Operations Centers have implemented standard screening criteria for data acceptance. Each CRD data entry is checked in order to determine if invalid information was being reported by a station. The NESC was asked to provide its input.
- *Matthew Wilkinson* asked *Chris Moore, Jens Steinberg and Jean-Marie Torre* to form a small group to provide NESC input. The individuals had a range of SLR and LLR experience, using different hardware. This was carried out on email and this group provided feedback and was eventually able to approve these values on behalf of the NESC.



FIRST NESC WORKING PANELS

- **Alternative normal point methods to reduce systematic errors for single photon SLR systems.** On-site data screening can be done in different ways but the normal point calculation is well defined applying the mean residual at a central epoch.
- **Stefan Reipl** has agreed to form a working panel to explore the advantages of using other methods to form normal points.



FIRST NESC WORKING PANELS

- **Assessing the automation levels of ILRS stations.** Jens Steinborn proposed a survey looking in to the automation levels at stations.
- I invited him to do this with NESC support



PROPOSED NESC WORKING PANELS

- **How can stations demonstrate their high achieving performance to funding bodies?** Every SLR station has to justify its continued funding and operations. How could this be best argued and communicated in ways that apply to many stations? Could the ILRS better demonstrate the importance of the work at SLR stations?
 - *I think we do need a good brochure that explains what we do and why it is important. Some nice pictures and diagrams so people can understand, Pearlman*
 - *It is - and always was - difficult for us to argue (for getting money) with routine tracking of ILRS targets, Our Academy just does not acknowledge continuous routine data collection (although it is - and always has been - a major task to keep everything operational). It has proven (for us) to be much more efficient to start activities like space debris laser ranging (most of our present project-oriented money comes from space debris related experiments / tasks / research & developments), or quantum key distribution via satellite, or developing high-tech detection packages etc. etc. Kirchner*



PROPOSED NESC WORKING PANELS

- **Meteorological measurements at SLR stations.** Meteorological devices are used to make critical atmospheric delay corrections to SLR measurements. Therefore, the choice of the equipment, the installed location, height corrections and calibration are important. Are all stations carrying out this task as best as they can? Should a calibration campaign between stations be repeated?
 - *This is very important. Maybe even redundancy. It is terrible to spend large sums on equipment and operations, and then have the measurements corrupted by biased met data. Pearlman*



PROPOSED NESC WORKING PANELS

- **Monitoring the invariant point and the impact of temperature change.** It is difficult to determine exactly the invariant reference point and even more difficult to monitor it for change. Are stations using the best methods and what accuracy can be expected? How do stations monitor the eccentricities of the reference points of all space-geodetic instruments?



PROPOSED NESC WORKING PANELS

- **Catalogue of recommended equipment.** Lots of different timers, detectors, lasers and telescopes are in use in the ILRS network. Could these be better catalogued and characterised for those looking to upgrade?
 - Toshi asked Georg in the session on Monday where he finds the instruments he uses.
 - Toshi also expressed interest in low cost COTS components



PROPOSED NESC WORKING PANELS

- **Accurate site surveys.** Independent measurements of the calibration distance and the site- ties to other geodetic techniques are of great importance and should be repeated every few years. What are the best, most reliable, methods? Can stations perform their own surveys?
 - *I agree that the periodic measurement are very important. I also believe that the biggest problem may be the connection with the instrument reference point. My guess is that many groups do not do the best job at this. This is crucial for the reference frame.*
Pearlman



PROPOSED NESC WORKING PANELS

- **How accurate are the timing references at SLR stations?** Stations report epochs in their SLR data. These must take in to account electronic delays from the frequency source, the 1pps tick source, detector rise times and event timer stability. Are stations able to calibrate and monitor timing errors?
 - *As we have seen through T2L2, a number of the stations are working outside (some well outside) the 100 ns epoch timing criteria. We should understand the behaviour of the timing systems components, but we really need routine clock synchronization from space also with better understanding of how epoch reference propagates through the systems. May there are some procedures that could monitor this. Fundamental issue.*
Pearlman



OTHER POSSIBLE TASKS FOR THE NESC

- In-sky safety
- Ground calibration best practice
- Systematic bias
- Getting the best mount model
- Effects of polarisation on SLR
- How to SLR reference manual
- Synergy applications with SLR
- Two-colour ranging
-
-



OTHER TASKS??





UK Research
and Innovation

NERC
SCIENCE OF THE
ENVIRONMENT



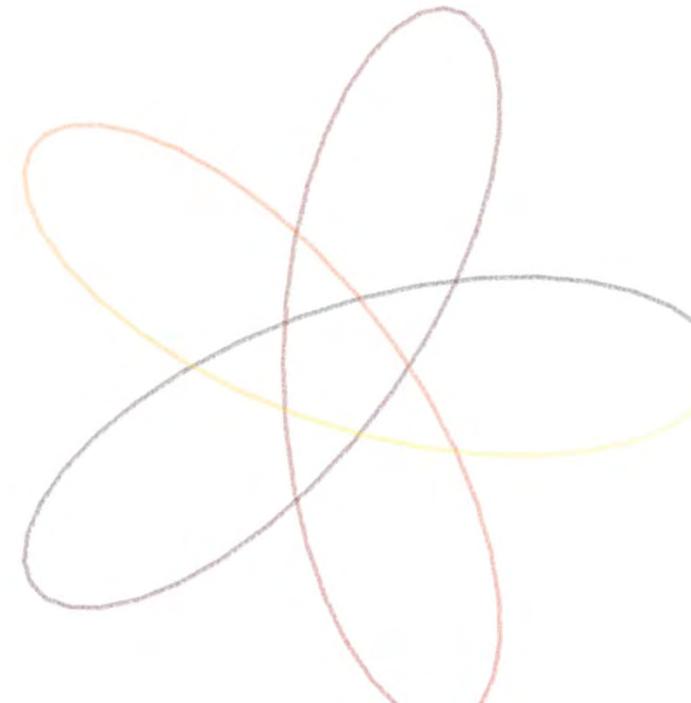
THANK YOU



matwi@nerc.ac.uk



<http://sgf.rgo.ac.uk>



Technical Laser Ranging Workshop Stuttgart 2019 / ILRS GB Meeting

Space Debris Study Group - an Update

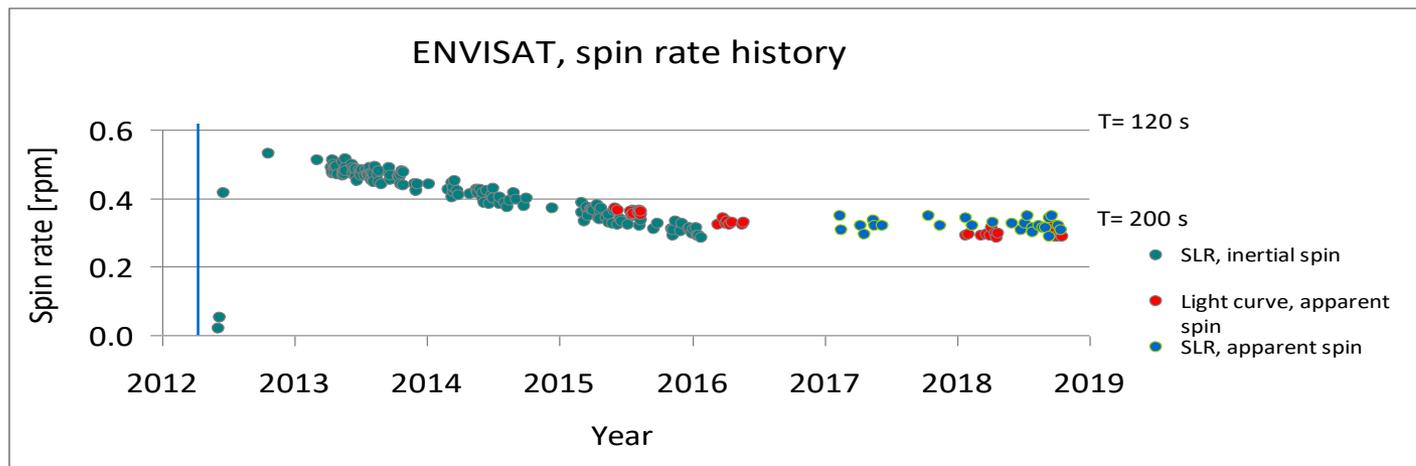
Georg Kirchner

SDSG: Recent Problems / Solutions

- SDSG TLE2CPF Conversion Program (by Daniel Kucharski):
 - Since August 2019: Problems to access TLE files (Space Track)
 - New SSL protocol / TLS version 1.2 or higher
 - Graz: switched to internal TLE2CPF conversion
- ENVISAT
 - Very sparse ENVISAT data (from June 2019)
 - Predictions falling back to TLE => increased problems
 - Since October 2019 enough data again for good CPFs
 - A few passes per week needed for accurate CPFs (and spin parameters...)
 - Spin rate stabilized at approx. 180 s



Space-Track will discontinue support for TLS 1.0/1.1 on August 1, 2019. Please update any software/scripts that use these protocols. We will continue to support TLS 1.2 and will add support for TLS 1.3 as soon as it is available. You can go to <https://www.ssllabs.com/ssltest/analyze.html> to see which ciphers our website currently supports.



SDSG: Recent Progress

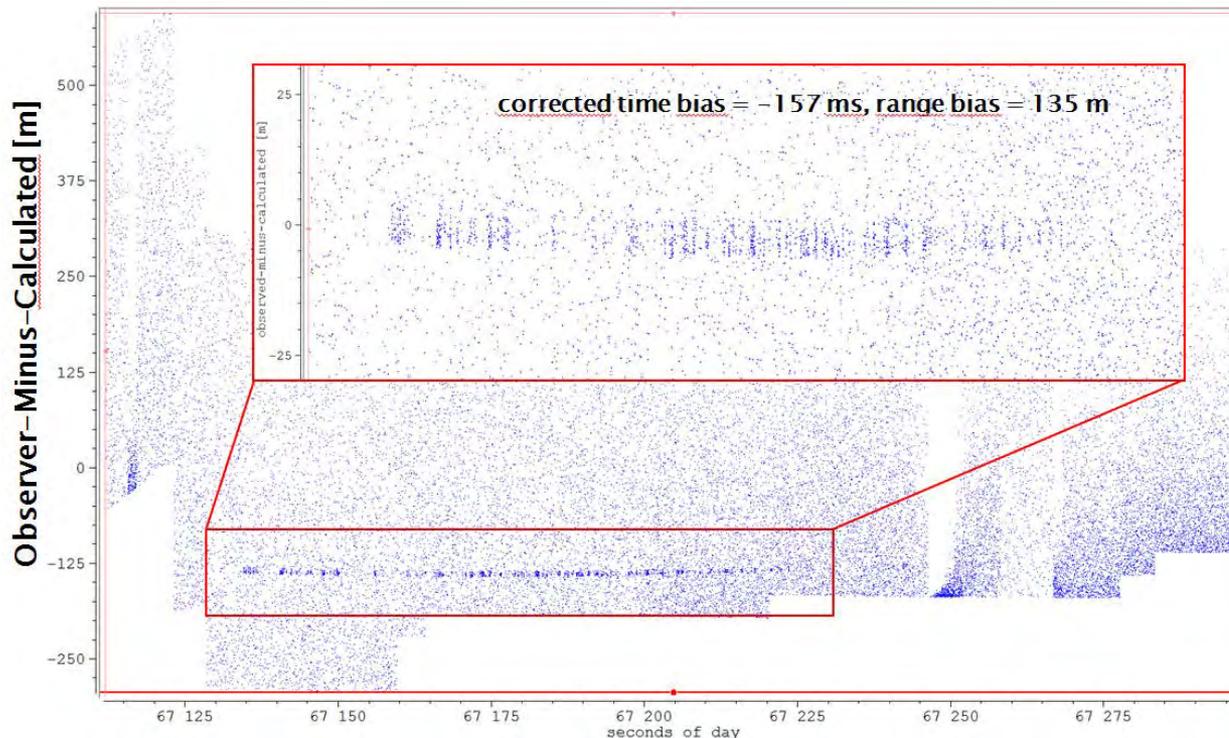
- Debris Laser (Innolas) mounted on main telescope: Operational in Graz
- 16 W @ 200 Hz // 532 / 1064 nm
- Laser head directly on mount, Cooling + power through mount



SDSG: Recent Progress

Daylight Debris Laser Ranging: First success... But still some work necessary

- Automatic optical target detection software
- Example: SL-16 R/B (NORAD 22803)
- Found at: $tb = -145$ ms, $rb = 0$ m // true: $tb = -157$ ms, $rb = 135$ m



SL-12 rocket body (NORAD 15772)



SDSG: Plans

- More SLR stations to be equipped with Debris Laser Ranging capability
- Goal: A - small - network of stations to track selected targets is needed
- Coordinated tracking of selected targets: China, Europe, ?
- Increased interest of ESA & DLR to track ERS-1, ERS-2, ENVISAT

- Ongoing Research: Use of diffuse reflections from surfaces of uncooperative targets for picosecond time transfer between SLR stations (Liu Tong / Wetzell)

- Ongoing Research: Use of SLR debris data to determine spin axis orientation (Zizi Zhao / Graz)

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GGOS Activities

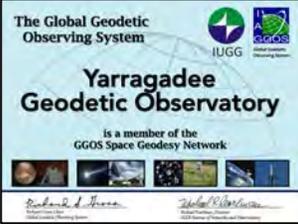
- New Chair (President) is Basara Miyahara (Geospatial Information Authority of Japan);
- Rebuilding the GGOS website by the GGOS Coordinating Office (Martin Sehnal); Meetings at GGOS Days/November, AGU 2019;
- New GGOS DOI Working Group formed under the leadership of Kirsten Elger (GFZ);
 - Simplifying Access to Geodetic Datasets using Digital Object Identifiers
 - Geodetic Data Publication and Citation Strategies using DOIs with Examples from GFZ Data Services
 - What does the community need; develop a strategy, opportunities/risks
 - Working Group meeting at AGU 2019 and EGU 2020;
- A lot of effort spent on Essential Geodetic Variables (EGVs); observed variables that are crucial (essential) to characterizing the geodetic properties of the Earth and that are key to sustainable geodetic observations;

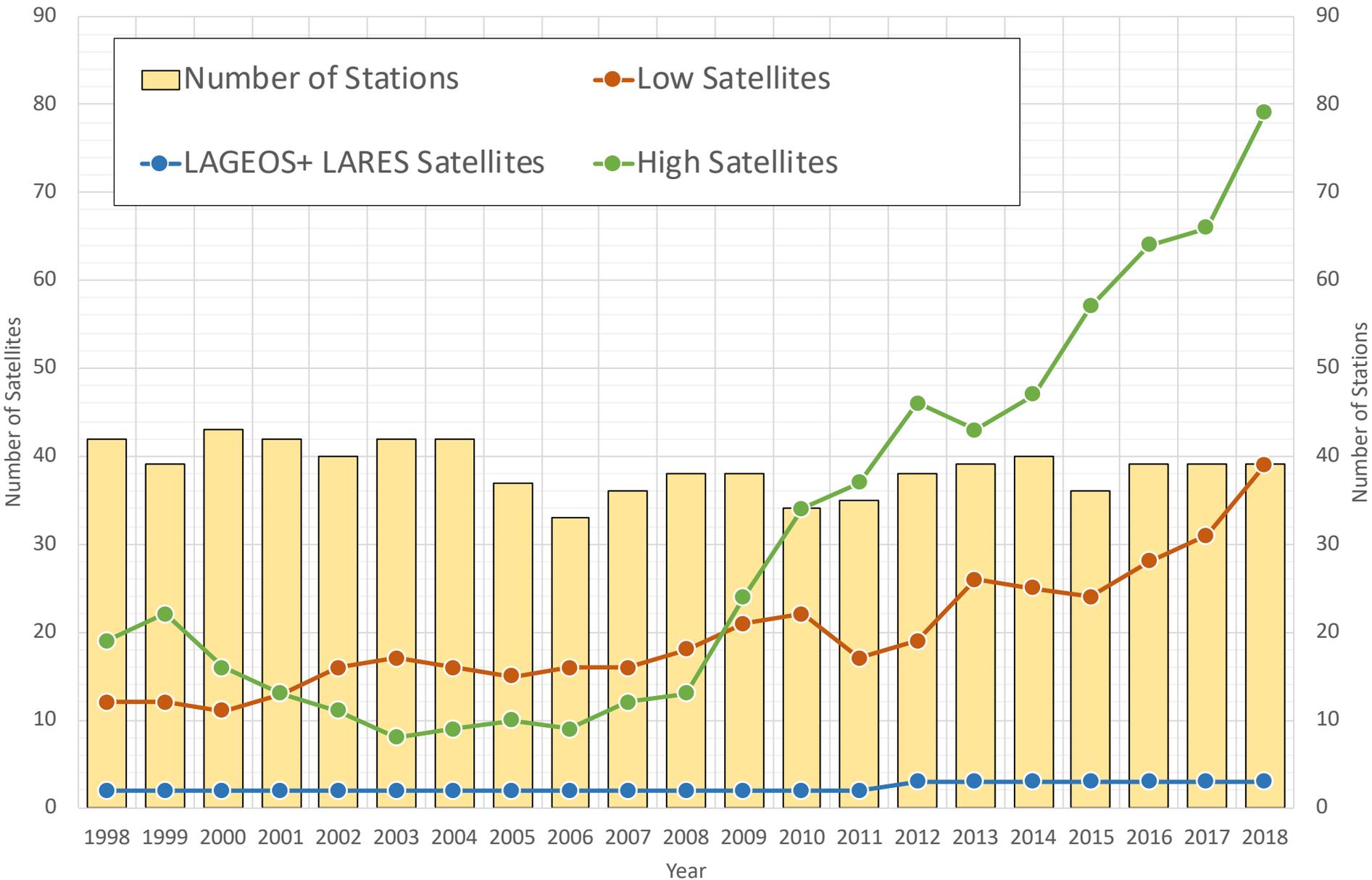
GGOS Bureau of Networks and Observations

- Working on the next update of the GGOS Site Guidelines Document (was GGOS Site Requirements Document);
- Working on next network projection;
- CfP in GGOS affiliated network continues; certificates for recognition sent out;
- IERS Working Group on Site Ties and Co-locations being reformulated under Ryan Hippenstiel (NGS)
- Work continues on Metadata
 - CDDIS continues efforts to complete collection level metadata in EOSDIS Common Metadata Repository; in addition, the CDDIS will begin a re-ingest activity later this year which will reload GNSS granule level metadata linked to these new collection level records (data products);
 - Nick Brown (Geoscience Australia) leads a study on the development of a Geodesy Markup Language (GeodesyML), for the GNSS community; potential for expansion to the other space geodesy techniques and GGOS. The current study is identifying metadata standards and requirements, assessing critical gaps and the how these might be filled, what changes are needed in the current standards, and who are the key people who should work on it (more comprehensive scheme)
- Poster at EGU; Talks at UAW (Paris), IUGG (Buenos Aires), GGOS Days/SIRGAS(Rio)
- Bureau meetings/Sessions at GGOS Days (October 2018), Vienna (2019), IUGG (2019)



The image shows a grid table with multiple columns and rows. The columns are color-coded in yellow and orange. The rows appear to represent different sites or parameters, with some cells containing numerical values or text. The table is organized into several vertical sections.





[2] Message/Request to ICG or GNSS Community?

Background:

The number of LRA-equipped GNSS satellites has increased so much.

SLR data plays an important role in calibrating the orbits and improve the force model (SRP etc.).

SLR stations are much busier now.

Possible action:

How about sending a request to the GNSS satellite providers so that they could support ?

Via ICG (International Committee on GNSS)?



ILRS Governing Board Election Process

Carey Noll
Michael Pearlman
ILRS Central Bureau

2019 ILRS Technical Workshop
October 21, 2019
Stuttgart, Germany

Outline

- Terms of Reference
- Recommendations
- Questions?

ILRS Governing Board: 2019-2020



- Elected positions:
 - ◆ EUROLAS Network Representatives: **Pippo Bianco, Georg Kirchner***
 - ◆ NASA Network Representatives: **Jan McGarry, Stephen Merkowitz***
 - ◆ WPLTN Representatives: **James Bennett, Zhang Zhongping**
 - ◆ Data Center Representative: **Christian Schwatke***
 - ◆ LLR Representative: **Jean-Marie Torre***
 - ◆ Analysis Representatives: **Cinzia Luceri*, Erricos Pavlis***
 - ◆ At-Large Representatives: **Toshi Otsubo* (Chair), Matt Wilkinson***
- Ex-officio/appointed positions:
 - ◆ Director of the Central Bureau: **Mike Pearlman**
 - ◆ Secretary of the Central Bureau: **Carey Noll**
 - ◆ Representative of IAG Commission 1: **Urs Hugentobler**
 - ◆ IERS Representative: **Daniela Thaller**
- Appointed by the Governing Board:
 - ◆ **Ulli Schreiber***
 - ◆ **Krzysztof Sośnica**

Note: * SC/SG chair/co-chair



Elections: from ILRS Terms of Reference



- Call for Nominations and GB Elections conducted bi-annually by the Central Bureau using official email lists
- Board members serve two-year terms starting on January 1
- For lunar, data center and analysis representatives:
 - ◆ GB nominees must be associated with that ILRS component
 - ◆ Only ILRS associates officially participating in that component, as determined by the official email lists maintained by the CB, may participate in the election of their representatives
- Full ILRS membership can nominate and vote for At-Large Representatives
- Election is by majority of votes received
- GB elects Chairperson from among its members for term of two years, renewable for one additional term (total of 4 years)

Election process: improvements



- Institute a more formal process, utilizing process similar to IGS, IDS
- Appoint election committee (chair+2)
- Start election process 6 months (minimum) prior to workshop and establish a clear schedule
- Conduct elections by "category" (lunar, analysis, data center, at-large)
- For each received nomination:
 - ◆ Confirm nomination with nominee
 - ◆ Request CV + statement from nominee
- Distribute (and then count) ballots through email (election committee)
- Communicate results to nominees/elected/community
- CB can continue assist in election process
- GB for 2021-2022 term (16 members) must be in place prior to 22nd International Workshop on Laser Ranging in Kunming (October 2020)

Proposed schedule: 2021-2022 election



1. Call for ILRS associates review of organization's membership ← April 2020
2. Call for appointed and network representatives: ← May 2020
 - ◆ Appointed: IERS (1), IAG Commission 1 (1)
 - ◆ Networks (conduct their own elections): NASA (2), WPLTN (2), EuroLAS (2)
3. Conduct (concurrent) elections for other positions: ← June 2020
 - ◆ Representatives for Lunar (1), Data Center (1), Analysis (2)
 - ◆ Nominations and voting limited to ILRS associates within these communities
4. Conduct elections for At-Large Representatives (2): ← July 2020
 - ◆ Voting on these positions from all ILRS associates
5. Following appointment/election of above 16 members:
 - ◆ Call for nominations for GB chairperson ← September 2020
 - ◆ Call for nominations of GB appointed members (2) ← September 2020
 - ◆ Elect chairperson (at GB meeting) ← October 2020
 - ◆ Elect GB appointed members (at GB meeting) ← October 2020

Planning Future Workshops

Planning future workshops: background

- ILRS had not had a clear rule.
- Host candidates could not see what will happen when.
- Decision < 1 yr in advance may be too short.
- Odd-year workshops were held only in Europe.
- Contents of odd-year workshops sometimes overlap with those of even-year ones.

Recent News

Meetings

Organization

Terms of Reference

Membership

ILRS Workshops

Publications & Reports

ILRS Annual Reports

Meeting Reports

Bibliography

ILRS Workshops

Links

Early History of ILRS

Quick Links

- › [Contact ILRS](#)
- › [Join ILRS](#)
- › [Network Map](#)
- › [Cite the ILRS](#)
- › [List of Missions](#)

Guidelines for Planning International Workshops on Laser Ranging and ILRS Technical/Specialized Workshops PDF

The ILRS sponsors International Workshops on Laser Ranging (IWLR) which are typically held every two years. In addition, the ILRS organizes focused technical or specialized workshops in years between the International Workshops on Laser Ranging. More information about these workshops, as well as links to their dedicated websites, is available on the ILRS website at:

<https://ilrs.gsfc.nasa.gov/about/reports/workshop/index.html>

International Workshop on Laser Ranging (IWLR)

- An IWLR should typically be held every two years (as practicable).
- The host of a future IWLR should be selected at the previous IWLR by vote of the meeting attendees; the ILRS Central Bureau will send out a notice three months prior to this meeting so that possible candidates can organize their proposals for presentation prior to the vote.
- The IWLR host is expected to coordinate/organize the posting of presentations, workshop and splinter meeting summaries/actions, and proceedings for posting on the ILRS website.
- The ILRS Standing Committees (SCs) and Governing Board (GB) will hold splinter meetings at the workshop and provide summary material at the closing session of the workshop.

Technical/Specialized Workshop

- These workshops may be held in the intervening years between the IWLRs; such workshops should be on focused topics of current importance for planning purposes.
- The ILRS CB will issue a request for proposals to host a future workshop 1.5 to 2 years in advance. Interested organizations should submit their response to the ILRS CB for review followed by final approval by the ILRS GB. After that time, the host organization selected by the Governing Board is requested to present their workshop plan at an IWLR of the previous year; alternatively, the GB may accept a proposal for a workshop with shorter notice.
- As with the IWLR, the organizer of these workshops should coordinate the posting of presentations from the meeting as well as summary reports with key issues and recommendations; proceedings can be proposed for posting.

Schedule for future ILRS workshops (as of October 2019):

- 2020: 22nd International Workshop on Laser Ranging, Kunming, China in October
 - Presentation on plans for this workshop to be presented at the 2019 ILRS Technical Workshop
- 2021: Technical/Specialized Workshop, location/timeframe TBD
 - October 2019: begin search for host/location
 - January 2020: close acceptance of proposals and seek vote from GB
 - March 2020: notify proposed host and announce location to community
 - October 2020: presentation from LOC in Kunming (22nd IWLR)
- 2022: 23rd International Workshop on Laser Ranging, location/timeframe TBD
 - July 2020 (3 months before the IWLR in Kunming): begin search for host/location
 - October 2020 (at the IWLR in Kunming): presentation by host candidates and vote by attendees

N-th International Workshop on Laser Ranging (IWLR)

- ILRS shall make every effort to happen it every 2 yrs.
- Full series of ILRS meetings (GB, all SCs, WGs, ...) will take place.
- Proceedings papers are required.
- Decision of the next location/host should be made roughly 2 yrs in advance = the last previous workshop.
 - To start a host search 2-3 months before the workshop.
 - Presentations by candidates, and voting by all participants if multiple options are given.

Technical/Specialized Workshop (freely named)

- May (may not) be held in the interleaving year of IWLR. Multiple meetings are possible.
- Less formal. Possibly small size. Unique/timely themes are encouraged.
- Proceedings papers are not mandatory.
- Decision of the next location/host should be made roughly 1.5 yrs in advance.
 - To start a host search by CB 1.5-2 years in advance.
 - Decision made by GB.

Timeline for 2020-2022 workshops

2020: 22nd International Workshop on Laser Ranging, Kunming, China in October

- Presentation on plans for this workshop to be presented at the 2019 ILRS Technical Workshop

2021: Technical/Specialized Workshop, location/timeframe TBD

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Other Topics

- ILRS Lunar Ranging Entity (Ulli Schreiber)
- Issues from the Workshop
 - Predictions – status, Quality Lapses
 - Mission Status – User Survey, followup with missions and user needs
 - Epoch timing issues – Procedures vs hardware (100 microsec)
 - Automation – Jens Study
 - Site Surveys – technique education? Common issue with other techniques, How do we perform them more frequently
 - Better monitoring and follow up on station performance; defined interface for station performance and procedures (Operations specialist?)
- How broad a field should the ILRS cover? Nature/Role of Laser Workshops
 - Laser comm, etc.
 - Debris tracking